

# **Report of the 1999 Goddard Space Flight Center Space Sciences Visiting Committee**

## **Introduction**

The Space Sciences Visiting Committee — David Chenette (Lockheed Martin Advanced Technology Center), Gordon Garmire (Pennsylvania State University), Samuel Gulkis (Jet Propulsion Laboratory), Martin Israel (Washington University), John Leibacher (National Solar Observatory, Visiting Committee chair), Gary Melnick (Harvard-Smithsonian Center for Astrophysics), and Patricia Reiff (Rice University) — met to assess the overall health of the Space Sciences Directorate at the Goddard Space Flight Center (GSFC) April 29–30, 1999. In addition to reviewing the overall Code 600 program with Steve Holt, Director of Space Sciences, and staff, the Visiting Committee conducted an in-depth review of Code 690, the Laboratory for Extraterrestrial Physics (LEP), and held a number of private meetings with the staff. The Committee also had extended discussions with Associate Center Director M. Kicza and Center Director A.V. Diaz. The Visiting Committee very much appreciates the care given by the staff in preparing the meetings, the materials made available beforehand, the quality of the presentations, the access to staff, and the hospitality afforded the Committee. We hope the comments that follow will be helpful to management and staff, and we thank them for the thoughtfulness and candor of their presentations.

## **Overview of Space Science at Goddard**

The Visiting Committee was favorably impressed by the vitality, breadth, and depth of the science being carried out within Code 600, as well as by the creativity in development of new technologies and mission concepts, and the leadership and support of the broader community in these endeavors. Excellence abounds despite significant difficulties in staffing and funding, in a — sometimes dishearteningly — rapidly changing environment. The Directorate maintains its enviable position as a world leader in Space Sciences.

The Directorate is involved with many significant changes in its organization and operations. These include the recently-completed engineering reorganization, preparation for ISO-9001 registration, ODIN for desktop computer provision, replanning for office and laboratory space utilization, the transition to full cost accounting, and other Center- and NASA-wide initiatives. Each of these changes presents a unique set of challenges to the Directorate and its management. Directorate management has done an excellent job in grappling with these issues and the staff clearly recognizes this. The Visiting Committee believes that these experiences, and the manner in which they have been managed, have helped to improve communications with the Directorate and its sense of community. The “Space Sciences Directorate Operational Plan” evidences significant effort and provides an excellent shared vision for addressing these structural issues.

In the following, we address some of the most salient elements of the changes underway, and other issues in the ongoing program.

### **Full Cost Accounting**

The pending conversion of the Directorate, and NASA as a whole, to full cost accounting with cost recovery has been further delayed. The staff of the Directorate appears better prepared for the ultimate impact of this, when it arrives, than they were 17 months ago. The Visiting Committee offers a few recommendations about how better to use labor cost accounting as a beneficial tool.

The difference between direct work (on specific projects or contracts) and institutional support (not directly related to a specific project or contract) is clearly recognized. Based on experience in other organizations, the Visiting Committee suggests that it might be valuable to further divide the institutional support activities and to provide budgetary allocations for these activities to the Laboratory Chiefs, Branch Heads, and for some elements, even down to individual staff members.

Examples of specific categories to establish within the overall overhead category include "bid and proposal", expanded to include pre-bid exploration, concept and team development, and related pursuit activities; education and outreach activities; staff development and training; exploratory research; lab and facility development or maintenance; and self-development activities such as the study necessary to maintain currency in a specific discipline.

There are many potential benefits of such an approach. One is a better sense of empowerment and control by the staff over their working time and environment, especially for those items allocated to individuals. Another is to provide management advice or direction to the staff on the appropriate amounts of time to be spent in these various activities. Such budgets also provide for better tracking of the costs associated with each element. Clearly, the accounting infrastructure of the Center must be adequate to support such an approach. The Directorate has a vested interest in helping to insure that this infrastructure is adapted to be supportive of, and responsive to, its needs.

### **Implementation of ISO-9001**

GSFC is committed to achieving ISO-9001 certification this year. The Visiting Committee recognizes the significant investment of time and effort by the management of the Space Sciences Directorate to prepare their staff for this objective. While this has been a significant additional burden to management, the staff has reacted favorably and appreciates the care taken to help train them in this new system, to clarify the requirements, and to help control the impact of this new system on day-to-day activities.

Internal and subsequent external audits later this year will be necessary to establish that the Directorate is compliant with the ISO-9001 requirements. Passing these audits will require that each staff member understands what is required to conform to the new ISO requirements and feels confident with this understanding. The summary guidelines published by the Laboratory for Extraterrestrial Physics are an excellent aid in this regard and are one of the items cited favorably by the staff as helpful for their preparation.

For flight hardware development programs, Code 600 staff members are expecting to receive significant support in ISO requirements compliance from the engineering organization. The major concern, expressed to the Visiting Committee on the impact of the new ISO requirements, is how they will be handled by projects in the missions operations phase, when more of the program management will be the responsibility of Code 600 and less engineering support will be available. It appears that the staff may need additional guidance and training in the future to handle these more complex situations.

### **Engineering**

At its previous visit, in November 1997, the Visiting Committee heard serious concerns about possible adverse effects of the impending rebadging of engineers who had been part of Code 600. Now, in 1999, we are pleased to learn that the worst fears have not been realized. Many of the rebadged engineers are in fact still co-located with Code 600 scientists, and current projects have not been disrupted. The number of engineers supporting projects in Code 600 is no less than before the rebadging, perhaps even a bit more.

However, we have concern that engineering continuity may be lost as new projects request engineering help. There is concern that engineers are considered interchangeable — that a new project would request an engineer and get someone assigned who fits some broad skill requirements but does not have the experience with a particular kind of cutting-edge instrument technology that is required for producing the next generation of sophisticated instrumentation. A similar statement could be made for certain senior technicians, whose technical experience in a particular area makes them particularly valuable.

We recognize that for some engineers and technicians a matrix organization, which moves staff from one area of work to another, fits their abilities and interests very well. These individuals may well grow and do their best work in such an environment. But for other engineers and technicians, the best environment for growth and for significant contribution to the mission of the Center,

comes in an environment where they can become expert at the cutting edge of technical developments — where they are taking detector technology to new levels, made possible by their experience with what worked and did not work at earlier stages.

We also have concerns that engineers assigned to Code 600 for a specific task feel constrained from responding to requests from a scientist for a half-day of help on some new idea or other short immediate need without first getting approval from the line supervisor in Code 500 or Code 700. This barrier to responsiveness is undesirable in an organization that should be nurturing new and innovative ideas and is an important challenge to – at the same time – encourage and manage effectively.

It would be helpful if engineers were given some discretionary time that they could use without approval from their line supervisors. This discretionary time could be used in response to requests like those described in the previous paragraph. It could also be used for self-improvement activities like reading current trade journals or for developing some new engineering idea. In the context of full-cost accounting, this might be seen as part of “staff development” and/or “exploratory research”.

### **Mission Operations**

The Visiting Committee was appraised of pending changes in the organization of mission operations, and specifically concerns by project scientists that the separation of mission operations from data analysis would be disruptive in the short term and a lack of clear lines of authority in the future could be detrimental. The Visiting Committee views the project scientists’ role as one of the highest priorities in addressing Goddard’s mission of enabling scientific investigations, and views these changes with concern.

### **Communication**

In the previous report of this committee, we noted a sense “that some members of the directorate suffer from a lack of information about the future directions in which directorate management intends to lead them.” Our sense is that lines of communication have improved over the last year and half. Still, scientists at all levels would appreciate the opportunity to be more involved in key decisions, particularly those concerning the scientific programs of the laboratory. For example, the management decision process about which proposals to support might include inputs from a Directorate-based scientific peer review.

Although not specifically mentioned by the scientists with whom we talked, the Visiting Committee recommends that management actively involve the working scientists in the forthcoming decisions regarding reorganization of space.

On the positive side, we heard from several working scientists praise for Code 600 management for shielding them from some of the worst burdens of bureaucratic paperwork. They appreciate the fact that management has enabled them to comply with ISO-9001 without imposing too much of a burden on them.

### **Library**

Excellent library facilities and support are essential for any organization responsible for cutting-edge research, and rapidly escalating costs of scientific journals are creating significant problems at most research institutions. It is vital that Center management commits to increasing support for the GSFC library; yet we hear that library personnel, hours, and electronic access are being curtailed. This degradation of library capabilities needs to be reversed.

### **Travel**

We applaud the fact that Center management has recognized the need for increased travel funds for scientific meetings; however it has unfortunately been implemented this year at the expense of necessary scientific program travel. Center management must find a way of increasing the total travel budget for Center scientists. While it is important to increase travel funding for

scientific meetings, and we applaud efforts to do so, it is detrimental to the obligations of the staff when increased travel for scientific meetings comes at the expense of travel money needed for projects. This is a long-standing problem and a difficult balance to achieve; the Visiting Committee encourages continuing efforts to raise both sides of the equation.

### **The Long Duration Balloon Program**

The Long Duration Balloon (LDB) and ultimately the Ultra-Long Duration (ULDB) programs are potentially high science return projects from which Code 600 scientists as well as the broader community could benefit. Short of a Great Observatory, there does not exist another means to carry large ( $> 70 \text{ m}^3$ ), massive ( $> 1000 \text{ kg}$ ) payloads into a near-space environment. Sophisticated experiments operating at wavelengths ranging from  $\gamma$ -ray to the submillimeter as well as cosmic ray experiments have already been proposed for these platforms. Moreover, these experiments can be developed in relatively short times ( $\approx 3\text{-}4$  years) and at a fraction of the cost of a comparable space mission. In ways we outline below, the Visiting Committee believes that as a science Directorate, Code 600 is in a unique position to promote this initiative.

In many cases, the present perception of the scientific value of balloon experiments has been shaped largely by the modest amounts of data these experiments have been able to return during a single one-day flight per year. The advent of 10- to 20-day flights and ultimately 50- to 100-day flights could radically change this situation, making these flights more akin to space missions than their earlier ballooning predecessors. However, before this potential can be realized, current balloon support systems, such as power management, command and data handling, and telemetry, must be upgraded to accommodate longer flights in a way similar to that of present-day satellites. This is a natural task for GSFC for two reasons. First, the present NASA balloon program is resident at Wallops Island and thus is already a part of the GSFC organization. Second, the SMEX program at GSFC has already developed and flown compact, light-weight, rugged systems that could be transferred to the LDB/ULDB effort. Unfortunately, this transfer of know-how is not taking place and, as a result, the Wallops Island efforts appear to be lagging, further contributing to the sense that the balloon program is a relict of an earlier age. The Visiting Committee recommends that Code 600 pursue ways to bring these Wallops Island activities into closer contact with the small satellite groups on the Greenbelt campus.

### **Term Hires**

The Visiting Committee applauds Code 600 on its success in adding 13 term hires to the scientific staff along with plans to add another 5 hires in the near future. As everyone recognizes, the long-term health of the Directorate requires that young scientists be hired as the ranks of retirement-age staff grows. Moreover, the Visiting Committee is very impressed with the quality of the recent term hires - the quality of the research they presented to the Visiting Committee was uniformly high. The ability to attract good term hires is a clear indication that GSFC maintains an excellent reputation in the larger science community.

However, the Visiting Committee has two concerns. First, while we applaud management's very sincere efforts toward developing a more diverse scientific staff, the difficulty that we all share in approaching that goal cannot be underestimated. We note the added sensitivity at all levels to this imbalance and we encourage the ongoing efforts to increase staff diversity. Second, while the term hires with whom we spoke were uniformly pleased with both their positions and the work environment, concern was voiced about what some see as a lack of clarity in the job process beyond their four-year term. Contrast was drawn to universities, with long standing policies, where junior faculty is informed when hired of the earliest and latest dates they will be considered for tenure along with detailed information about the promotion evaluation process. It is both natural and reasonable that young people eager to secure long-term employment would be sensitive to all issues relating to this goal. The uncertainties are understandable, as this is a new status, whose parameters are still being defined, and the Visiting Committee recommends that the appropriate supervisor (*e.g.*, the Branch Chief or Lab Director) make certain that all new hires understand the terms of their employment along with the various options that can be exercised by GSFC as rapidly as possible.

## **Review of the Laboratory for Extraterrestrial Physics (LEP)**

The Visiting Committee heard presentations from Laboratory Chief R. Vondrak, the Branch Heads, and others, and visited laboratories from the five Branches (Astrochemistry, Planetary Systems, Interplanetary Physics, Planetary Magnetospheres, and Electrodynamics) within the LEP. The Visiting Committee was quite impressed with the breadth and depth of the research activities of the LEP. Clearly the Goddard scientists perform several functions critical to the community: serving as project or program scientists for a variety of missions, providing scientific leadership for spacecraft and research teams, and providing vital supporting laboratory measurements and instrument development, and advanced mission studies, as well as carrying out their own research programs. The Visiting Committee was pleased to see the strong interactions that Goddard scientists are having with the external scientific community.

In the relatively short time that we had to be briefed, we got a very stimulating taste of the quality of the research performed in the laboratory. The most exciting result was the fascinating discovery of stripes of Martian magnetization that was discussed at the press conference suggesting a period of plate tectonics, which was previously unknown on Mars. Once again, taking a particles and fields experiment to a new planet had yielded a spectacular surprise that has significant repercussions on other fields of inquiry. It is no wonder that the Goddard magnetometers have gotten flight opportunities on many extraterrestrial missions, and Goddard scientists have been part of so many flight proposals. This significant discovery is the result of a very long history of magnetometry experiments by this in-house Goddard effort. Our congratulations to all. Other research areas have also had dramatic breakthroughs. The Polar spacecraft has now observed fluxes of escaping atmospheric Oxygen and Hydrogen exceeding  $10^9 \text{ cm}^{-2} \text{ s}^{-1}$ . If a similar flux existed on Mars and Venus, the loss of planet-wide oceans of 10 m depth would occur over geologic time; only our magnetic field has protected Earth from such loss. FAST data now show the diverging electric shocks associated with the upward accelerated electrons of the auroral return current. Voyager is hearing the radio noise from the approaching shock at the heliopause. Instrument and mission development is another critical Goddard function. The clever “periscope” to observe the solar wind inside of 4 solar radii while deflecting the heat of 3000 suns is a case in point. Without instrument development such as this, groundbreaking missions such as Solar Probe cannot succeed. Finally, the choice of Goddard as the site of both the Sun-Earth Connections Educational Forum and the Community Coordinated Modeling Center recognizes the leadership of Goddard scientists and the breadth of their contribution to the community. Specific comments about individual Branches follow.

### **Astrochemistry Branch**

This Branch conducts basic laboratory measurements in support of research related to NASA programs in planetary atmospheres and surfaces, primitive small bodies (comets, asteroids, dust, *etc...*) and astrophysics. Measurements include kinematic rates, vapor pressure, line widths, gamma ray analysis of solids, and infrared spectra of pure and mixed ices. These activities are all related to ongoing NASA programs. The ongoing work appears to be of high quality. The Visiting Committee encourages this group to establish additional and closer ties to space scientists, modelers, and instrument science teams.

### **Planetary Systems Branch**

This Branch is focused on infrared spectroscopy of solar system objects, especially planetary, satellite, and comet atmospheres. The Branch has a long history of accomplishments including laboratory spectroscopy, earth and space-based observations, and instrument development. The VESPER, CIRS, and TES activities attest to the continued high quality of this group’s activities. The Visiting Committee supports the Branch’s efforts to develop capabilities for spectroscopic measurements of extra-solar planets.

### **Interplanetary Physics Branch**

This Branch is concerned with magnetohydrodynamics and kinematics of plasma atmosphere systems. These activities support Sun-Earth Connection missions. Activities within this Branch include theory, simulation, and instrument development. Currently the group is working on advanced development instrument concepts for Solar Probe. The group is carrying out interesting work on nanosatellite instrumentation as well.

### **Planetary Magnetospheres Branch**

This Branch provides important scientific leadership for NASA in the areas of magnetometry, low-frequency radio astronomy, and theoretical modeling of planetary magnetospheres. The magnetometry effort is unequaled outside of NASA. The low frequency radio group has been highly productive over the years, and currently is the only such group within NASA. This group is connected with the Voyager Planetary Radio Astronomy experiment, which is presumably hearing the radio noise from the approaching shock at the heliopause.

### **Electrodynamics Branch**

This Branch is composed of an Electric Field Group, a Magnetic Field Group, and a Magnetospheric Theory Group. The three groups are intimately connected with a large number of spacecraft including IMP 8, WIND, TRIANA, VOYAGER, FAST, POLAR, OERSTED, and CLUSTER II. Some of this research has resulted in dramatic breakthroughs discussed in the introduction.

The Visiting Committee has concerns about the continuing support for Ionospheric, Thermospheric, Mesosphere (ITM) science. With the retirement of several key researchers in the field and the single replacement, Goddard will soon be in the situation of having to perform project scientist duties on four upcoming major ITM missions (plus the rocket program) with only three ITM scientists. Having a “critical mass” is important to perform Goddard’s scientific and management duties. We hope that as opportunities for new hires arise that at least one of the new scientists has an ITM focus.

### **The Visiting Committee Itself**

It was very beneficial that the entire membership of the Visiting Committee was able to attend; the distribution of scientific disciplines and organizational backgrounds represented appears to be well-matched to Code 600’s activities. This was the first time that the Visiting Committee met at an eighteen month interval from the previous visit, and this frequency appears to be a reasonable compromise between the rapid pace of change within the Code and the effort expended in carrying out such a visit. The visit to the LEP was very useful, both in providing an in-depth view of the Lab’s activities, and as a microcosm of the activities of the Directorate as a whole. We feel that this rotation of specific visits among the principal activities of the Directorate is effective, and that it should continue, with cross-cutting activities receiving visibility in the Directorate-wide discussions. With the three Labs, and the typically three-visit appointment of the membership of the Visiting Committee, we recommend that one member of the Visiting Committee serve a fourth term to provide overlap, or “corporate memory” of the Lab’s previous visit. The Visiting Committee felt that it is useful for it to hold private meetings with groups of staff members, and it appreciates the flexibility of both management and staff in accommodating the request. We suggest that several hours be reserved in future agendas to accommodate such private discussions.